



Landsat 8 Mission Overview

presented at the

**2014 HysplRI Product Symposium
NASA Goddard Space Flight Center
June 04, 2014**

by

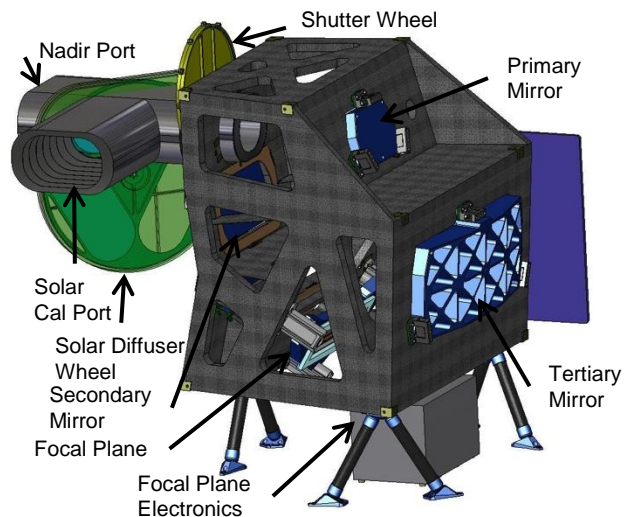
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Earth Science Division
NASA Goddard Space Flight Center
Greenbelt, Maryland**

Landsat 8 Launch – Feb. 11, 2013

- ◆ **Landsat Data Continuity Mission (LDCM) developed through an interagency partnership between NASA and the U.S. Geological Survey (USGS)/Dept. of the Interior**
- ◆ **LDCM launched Feb. 11, 2013 from Vandenberg Air Force Base (VAFB), California – ATLAS V 401 launch vehicle**
- ◆ **On-orbit commissioning completed May 30, 2013**
 - USGS assumed lead responsibility for mission operations
 - Satellite renamed Landsat 8

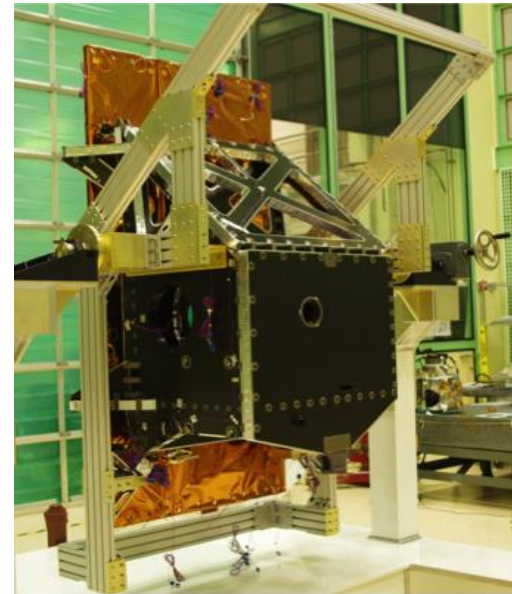
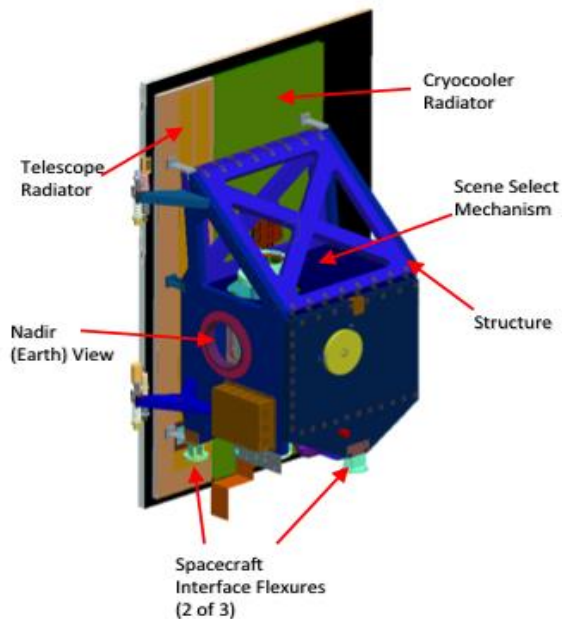


OLI Instrument on Landsat-8



- Pushbroom 15° FOV; 6916 detectors per spectral band row; 14 Sensor Chip Assemblies of 494 detectors each
- 9 bands Visible to SWIR (30 meter IFOV spectral with 15 meter IFOV pan)
- 4 mirror anastigmatic telescope
- Solar diffusers (2); Lamps (3) and shutter for calibration
- Designed and built by Ball Aerospace & Technologies, Boulder, CO (photo credit)

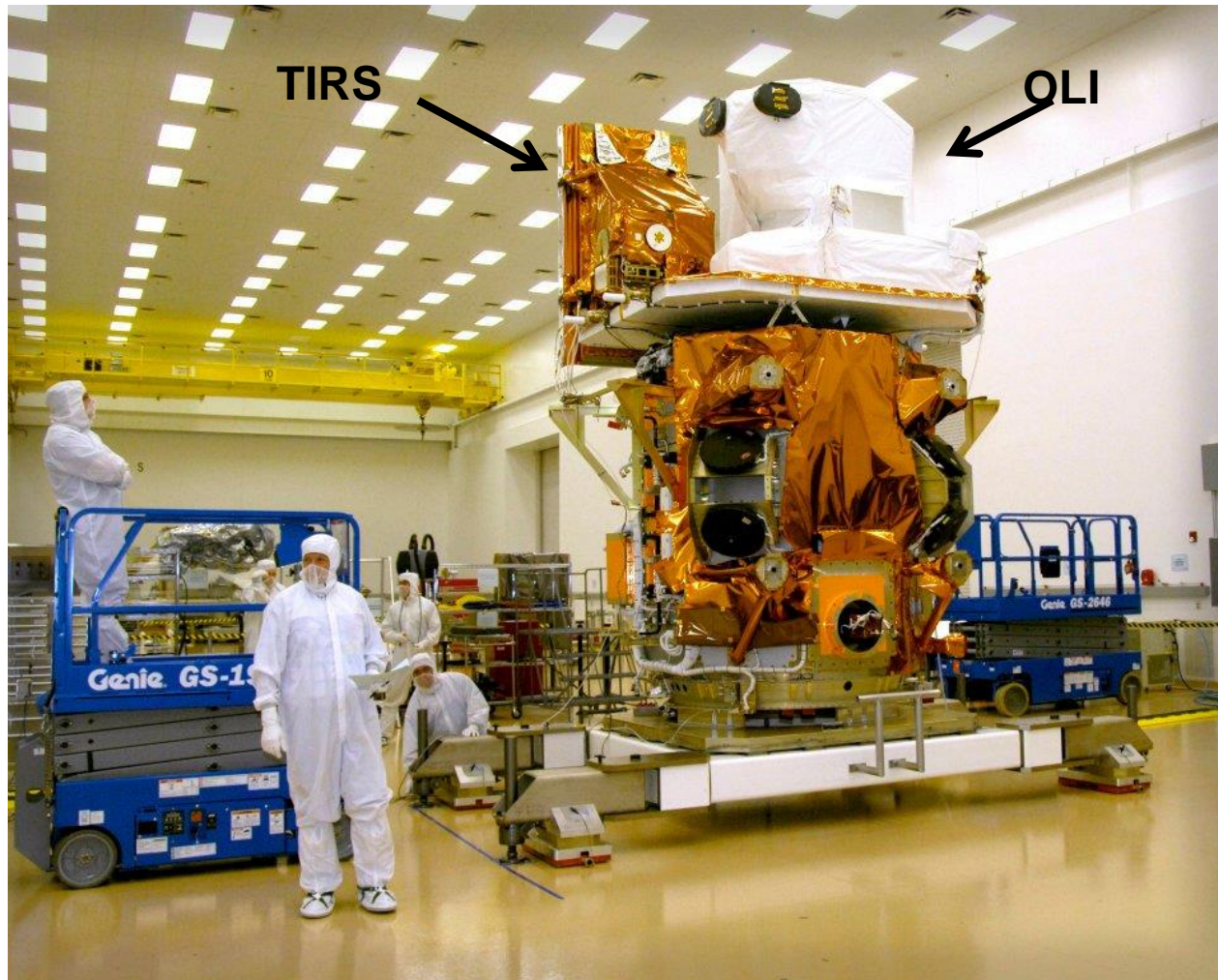
TIRS Instrument on Landsat-8



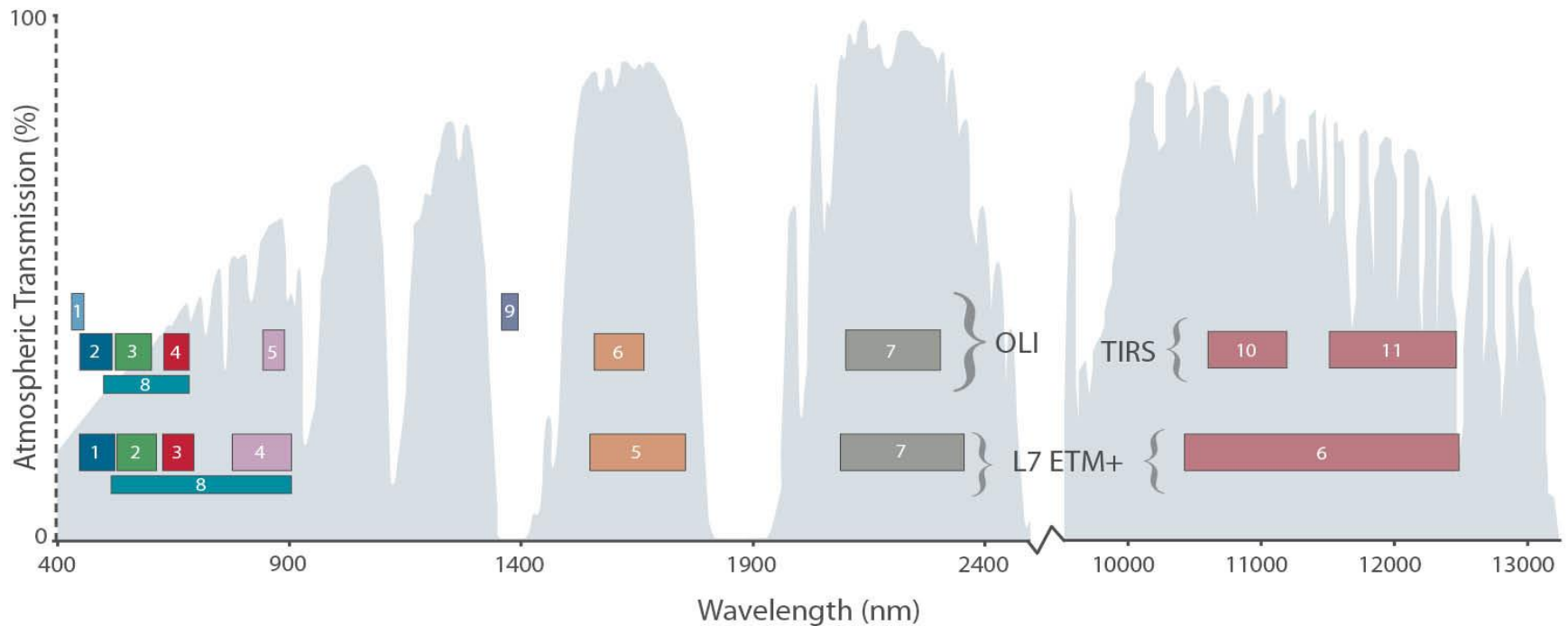
- Pushbroom 15° FOV; 1920 detectors/ band row; 3 Sensor Chip Assemblies of 640 detectors each; Quantum Well Infrared Photodetectors (QWIPs)
- Two 100 m IFOV thermal bands plus dark band
 - 10.9 μm (0.6 μm bandwidth) – “band 10”
 - 12.0 μm (1.0 μm bandwidth) – “band 11”
- Refractive optics
- On board blackbody and deep space view for calibration
- Designed and built by NASA/GSFC, Greenbelt, MD

Integrated Satellite Observatory

Orbital Sciences Corp., Gilbert, AZ, built the Landsat 8 spacecraft, integrated the instruments, and performed environmental testing of the integrated observatory



Landsat 8 Spectral Bands



- OLI & TIRS data are collected simultaneously
- OLI & TIRS collect raw data with a 12-bit radiometric resolution

Landsat 8 Performance Summary

◆ The performance of the Landsat 8 sensors, OLI & TIRS, spacecraft, and ground system exceeds specifications in almost all respects

- Landsat 8 collects, and USGS EROS archives, over 500 scenes per day compared to a 400 scene per day requirement
- By the first anniversary of the launch, USGS EROS distributed 1,332,969 Landsat 8 scenes (Level 1 digital data products)
- Scenes are typically available within 5 hours of data collection compared to a 24 hour latency requirement
- Image geometry and cartographic registration exceed specifications
- The radiometric performance of OLI and TIRS exceeds specifications with one exception
 - ❖ The absolute radiometric uncertainty of TIRS data currently exceeds a 2% requirement due to a stray light issue under investigation
- Early analyses are demonstrating backward compatibility with the Landsat archive and more accurate land cover mapping results

Panchromatic Band Refined



Landsat-7 ETM+

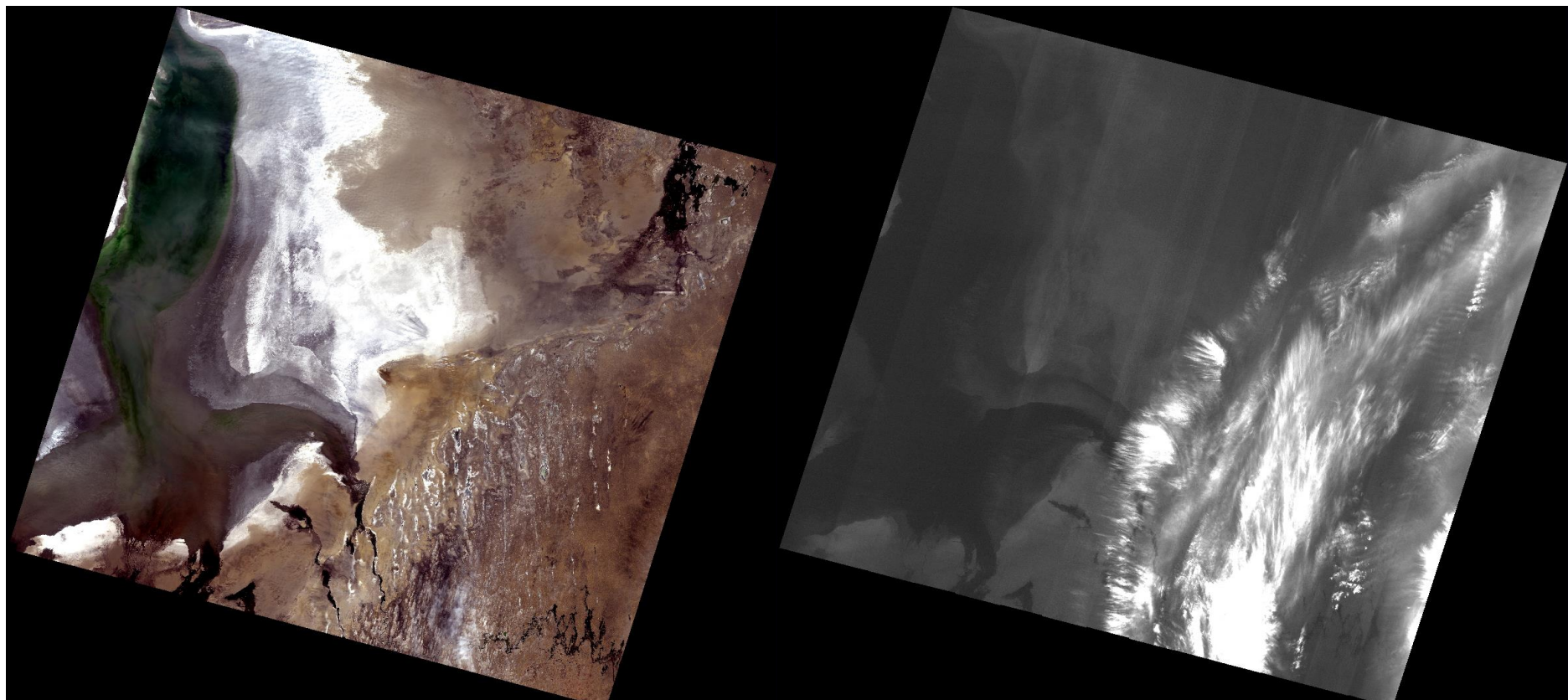


Landsat-8 OLI

OLI pan band confined to visible part of spectrum; provides higher contrast over vegetated areas;
Note better radiometry and spatial response as well

Path 38 Row 37 March 29, 2013

New Cirrus Detection Band



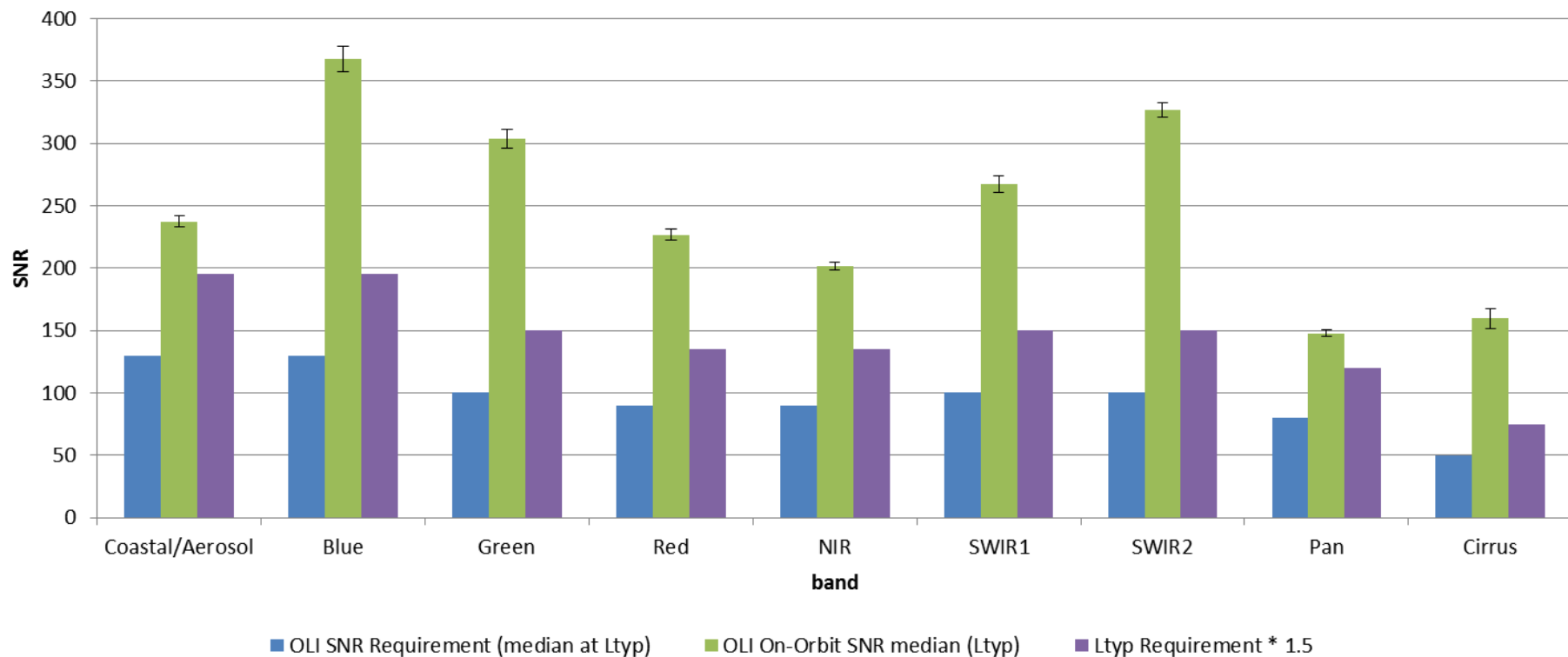
OLI natural color (4,3,2)

Cirrus band (9)

Better cloud detection and data filtering possible

OLI Signal to Noise Ratio

OLI Signal-to-Noise Performance at Ltypical
May-2014



Landsat-7 ETM+ Natural Color (3,2,1)

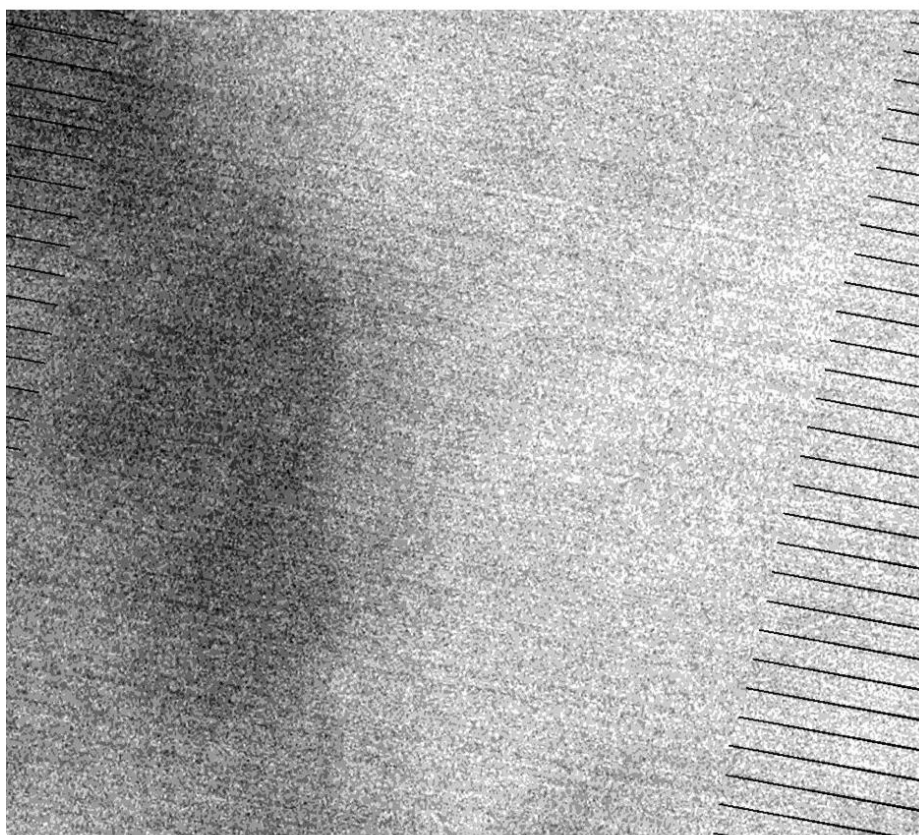


LDCM OLI Natural Color (4,3,2)

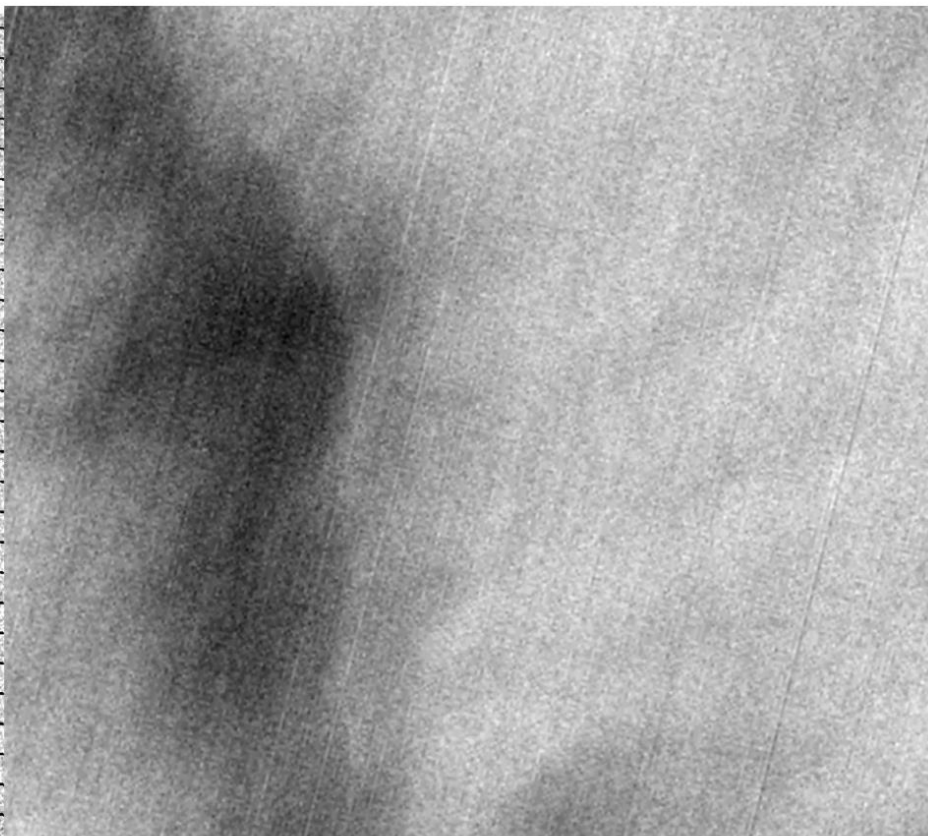


Improved Thermal Band Noise

TIRS noise exceeds requirements by a factor of ~ 6 ;
ETM+ performance by a factor of ~ 3



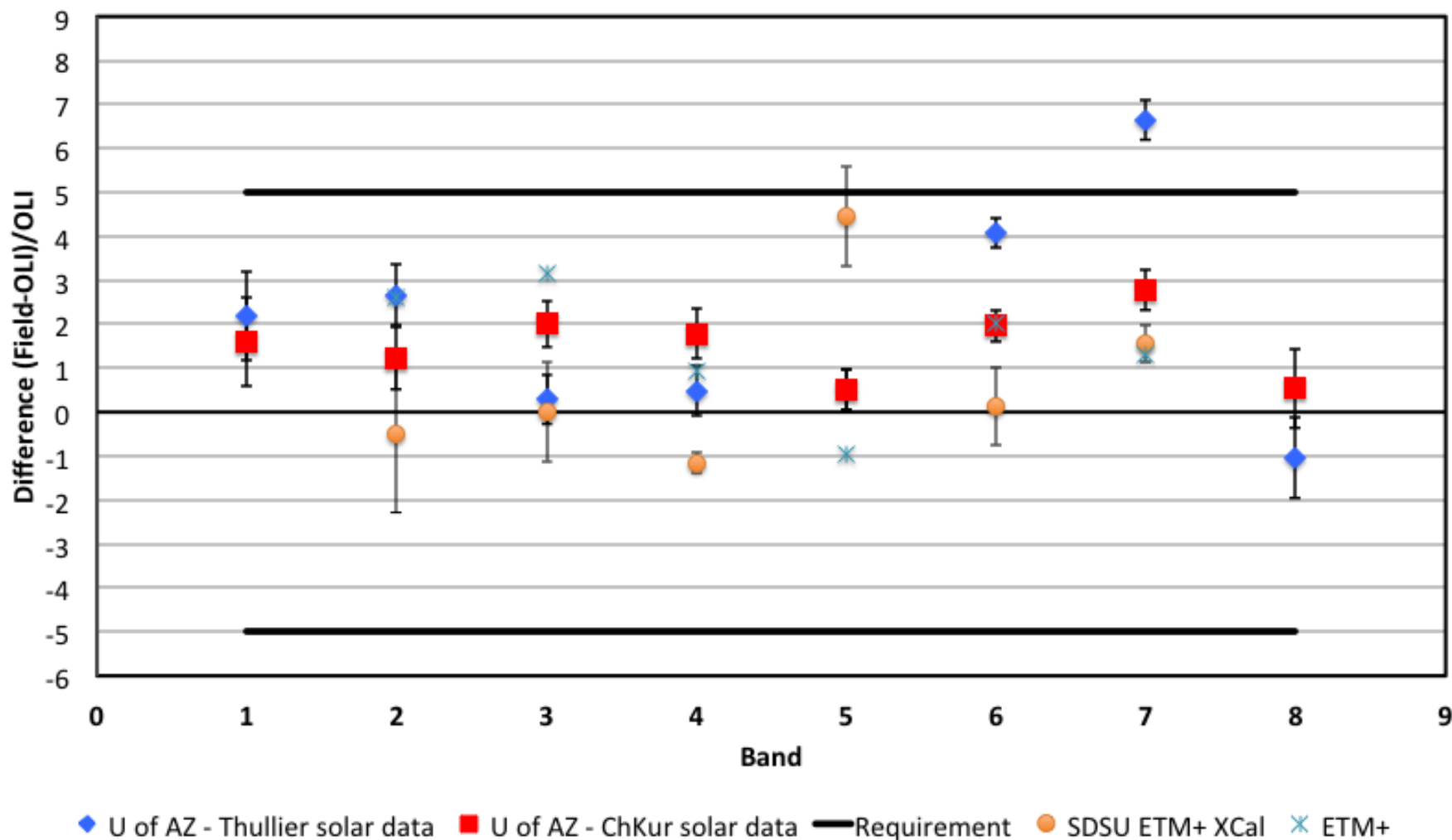
Landsat-7 ETM+ Band 6



Landsat-8 (TIRS) Band 10

OLI Absolute Calibration

OLI Radiance Calibration Validation Commissioning -- Expected based on Revised Cal



OLI Radiometric Stability

OLI SWIR1 Band 6 Trends: Band Average

Response Relative to Mission Day 75

Time Since Launch [years]

Legend:

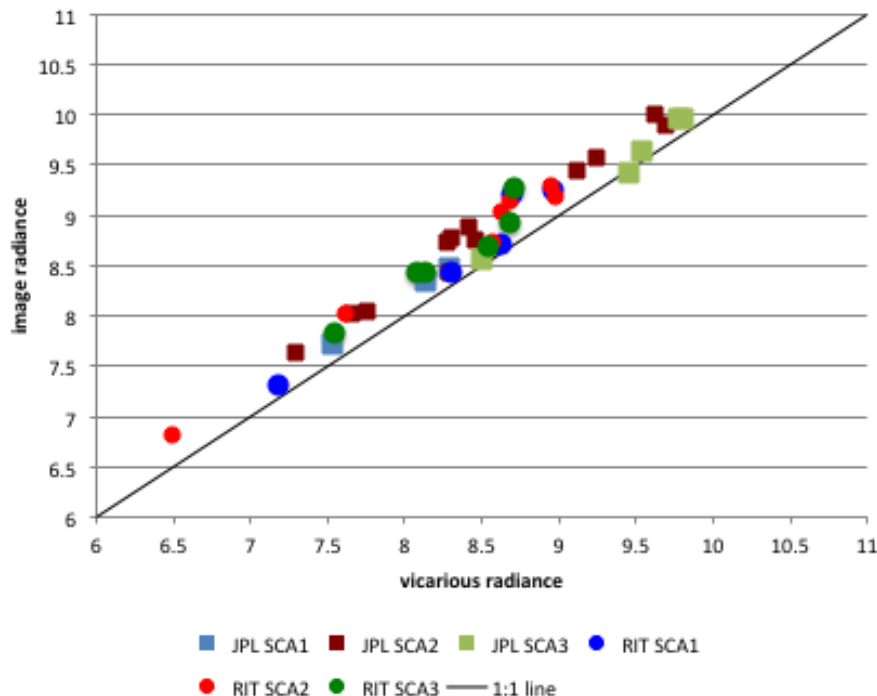
- stim lamp (working)
- stim lamp (backup)
- stim lamp (pristine)
- solar (working)
- solar panel (pristine)
- lunar



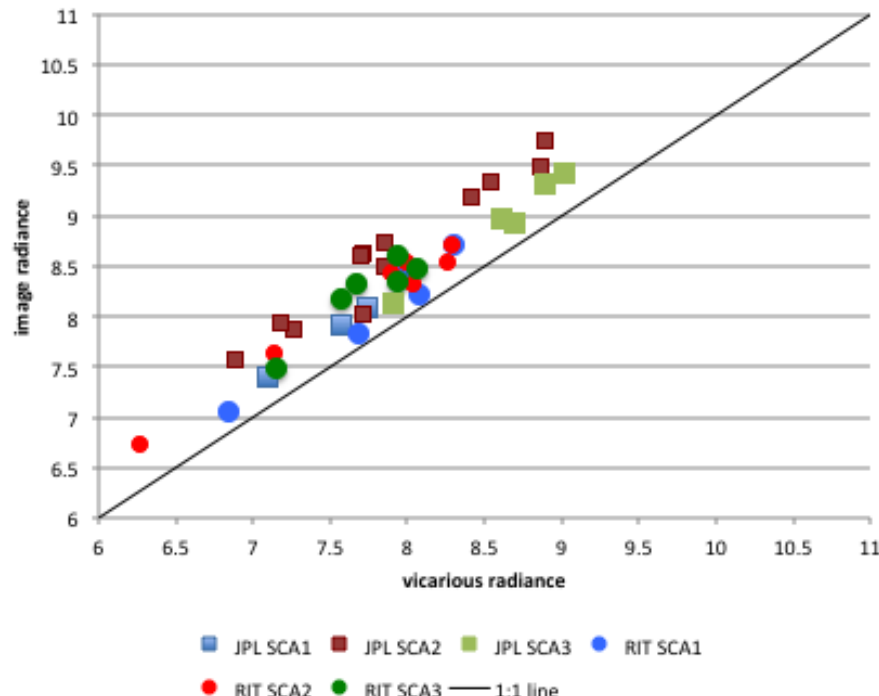
TIRS Absolute Calibration

Before February, 2014 Data Reprocessing

TIRS10 Calibration Results



TIRS11 Calibration Results



Before Data Reprocessing:

TIRS reported higher temperatures than expected (by ~2 K)

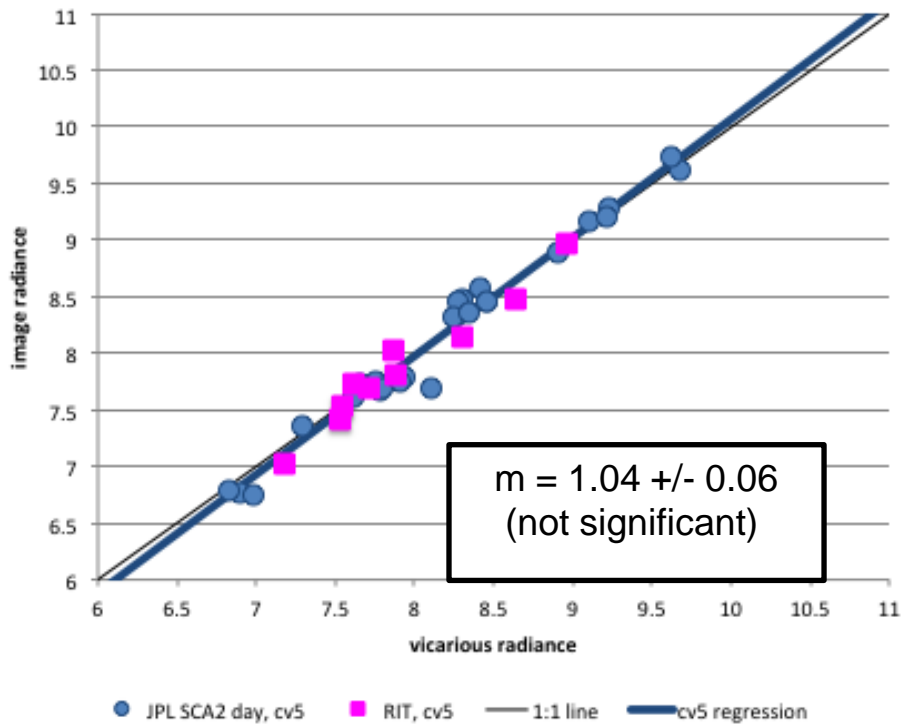
Significant variability in results, particularly in band 11 (12 micron band)

Source appears to be extra signal reaching detectors from outside the field of view – ghosting

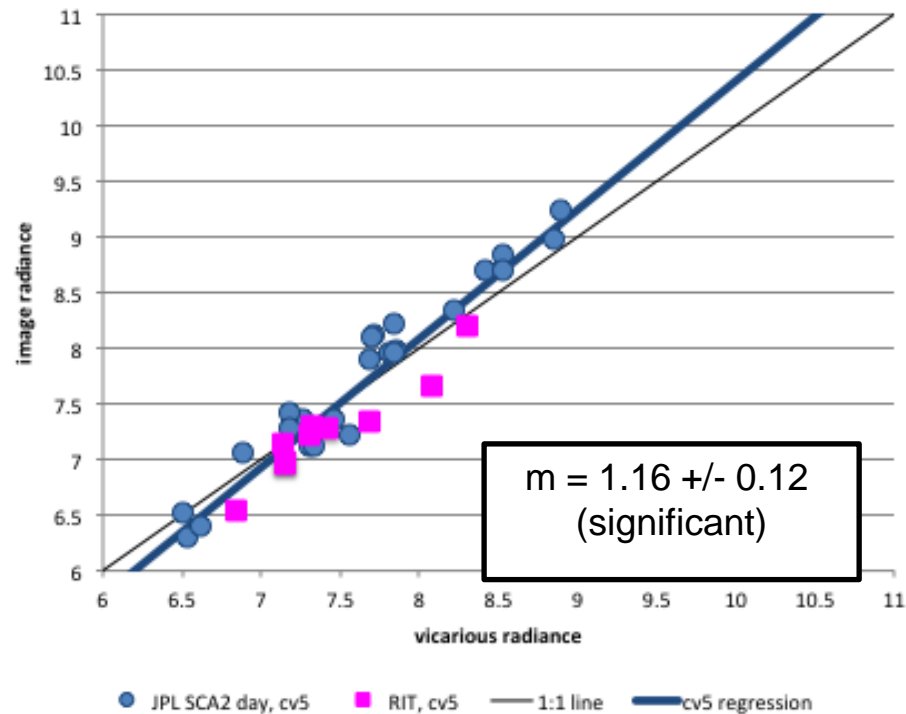
TIRS Absolute Calibration

After February, 2014 Data Reprocessing

TIRS10 Calibration Results



TIRS11 Calibration Results



TIRS Calibration Bias

Band	Before Reprocessing CPF Ver. 4 [W/m ² sr um]	After Reprocessing CPF Ver. 5 [W/m ² sr um]	After Reprocessing Temp RMSE [K]
B10	0.29 +/- 0.12	-0.03 +/- 0.04	0.88
B11	0.51 +/- 0.2	0.02 +/- 0.08	1.88

L8 Radiometric Summary

- ◆ OLI and TIRS significantly exceed noise requirements and ETM+ performance
- ◆ OLI and TIRS radiometrically stable; much better than requirements
- ◆ OLI data well flat fielded (radiometric matching of the ~7000 detectors per band)
- ◆ TIRS data well flat fielded on certain Earth scenes yet less so on others
 - Tied into out-of-field ghosting/stray light
- ◆ OLI Absolute Radiometric Calibration generally within $\pm 2\%$ of vicarious measurements –
- ◆ TIRS Absolute Radiometric Calibration improved by Feb., 2014 data reprocessing
 - Absolute precision remains a concern; worse in Band 11
 - Efforts underway to better understand source of ghosting/stray light and to improve TIRS data processing

OLI Band Registration Accuracy

- ◆ **Band registration accuracy is evaluated using cloud-free scenes of selected test sites**
 - Mainly desert sites are used
 - Data acquired between April 15, 2013 and November 14, 2013 (operational WRS-2 orbit)
- ◆ **Results from 334 OLI registration test scenes:**
 - 13 high-altitude Earth scenes were used for cirrus band registration assessment
 - OLI band registration accuracy (worst band pair)
 - ❖ Line Direction: 3.90 meters LE90 (with cirrus)
 - ❖ Sample Direction: 3.98 meters LE90 (with cirrus)
 - ❖ **Specification: 4.50 meters LE90**
 - ❖ Line Direction: 3.26 meters LE90 (no cirrus) (KPR #7)
 - ❖ Sample Direction: 3.33 meters LE90 (no cirrus) (KPR #7)
 - ❖ **Incentive Threshold: 3.80 meters LE90 (KPR #7)**

TIRS Band Registration Accuracy

◆ TIRS 10.8 μm to 12.0 μm band registration

- Results from 153 TIRS band registration test scenes acquired from April 15, 2013 to November 14, 2013

- TIRS band registration accuracy

 - ❖ Line Direction: 10.5 meters LE90

 - ❖ Sample Direction: 8.7 meters LE90

 - ❖ **Specification: 18.0 meters LE90**

◆ TIRS to OLI band registration

- Results from 143 TIRS-to-OLI registration test scenes acquired from April 15, 2013 to November 14, 2013

- TIRS-to-OLI band registration accuracy (worst band pair)

 - ❖ Line Direction: 22.1 meters LE90

 - ❖ Sample Direction: 20.4 meters LE90

 - ❖ **Specification: 30.0 meters LE90**

Geodetic and Geometric Accuracy

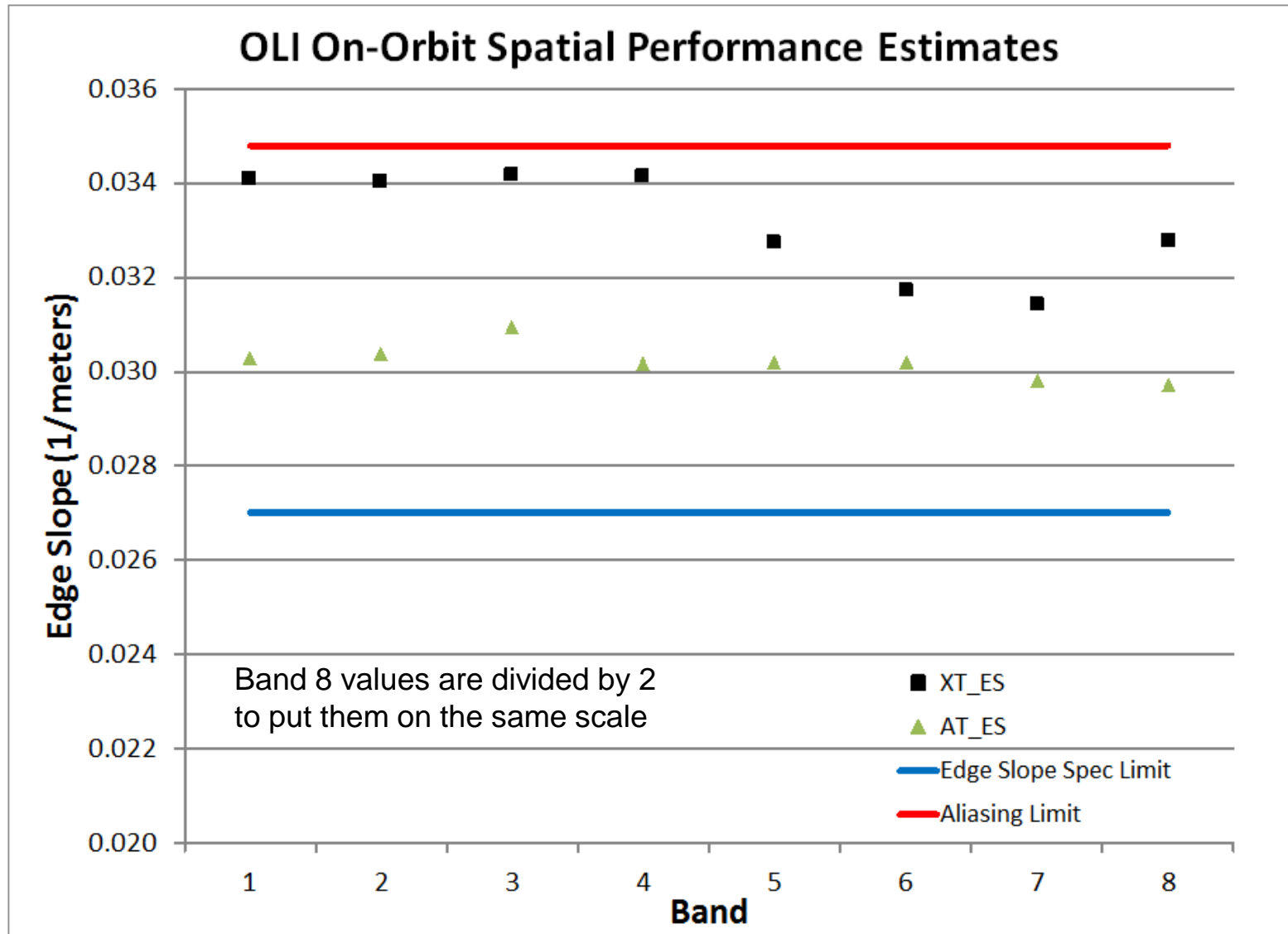
◆ Geodetic accuracy (prior to application of ground control) based upon 6595 scenes:

- Absolute Accuracy: 36.9 meters CE90
- **Specification: 65.0 meters CE90**
- Relative Accuracy: 19.9 meters CE90
- **Specification: 25.0 meters CE90**
- Reflects L8 absolute pointing knowledge accuracy

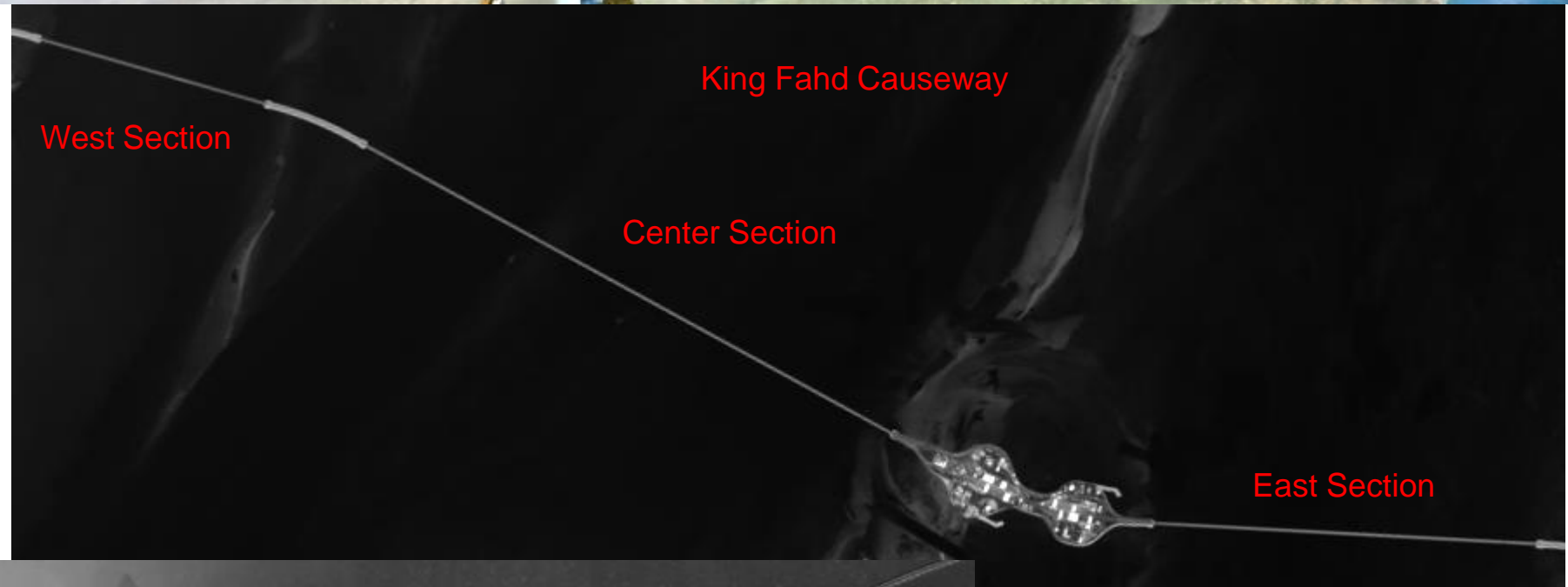
◆ Geometric accuracy (using independent validation points after application of ground control) based upon 6231 scenes:

- L1T Accuracy: 11.4 meters CE90
- **Specification: 12.0 meters CE90**
- Reflects Level 1T product accuracy

Spatial Performance - Edge Slope



Bahrain and China Bridge Targets



Panchromatic Band Images

Single Span Bridges

L8 Geometric Summary

- ◆ Landsat 8 on-orbit geometric performance is excellent and meets all requirements
- ◆ The Cal/Val team continues to monitor on-orbit performance, adjusting the calibration when necessary

Requirement	Measured Value	Required Value	Units	Margin
OLI Swath	190.2	>185	kilometers	2.8%
OLI MS Ground Sample Distance	29.934	<30	meters	0.2%
OLI Pan Ground Sample Distance	14.932	<15	meters	0.5%
OLI Band Registration Accuracy (all bands)	3.98	<4.5	meters (LE90)	11.6%
OLI Band Registration Accuracy (no cirrus)	3.33	<4.5	meters (LE90)	26.1%
Absolute Geodetic Accuracy	36.9	<65	meters (CE90)	43.2%
Relative Geodetic Accuracy	19.9	<25	meters (CE90)	20.4%
Geometric (L1T) Accuracy	11.4	<12	meters (CE90)	5.0%
OLI Edge Slope	0.03054	>0.027	1/meters	13.1%
TIRS Swath	186.2	>185	kilometers	0.6%
TIRS Ground Sample Distance	103.424	<120	meters	13.8%
TIRS Band Registration Accuracy	10.5	<18	meters (LE90)	41.7%
TIRS-to-OLI Registration Accuracy	22.1	<30	meters (LE90)	26.2%

U.S. Landsat Data Archive

USGS Earth Resources Observation and Science (EROS) Center
Sioux Falls, South Dakota



Landsat 8 data are free

Landsat 8 Performance Summary

- ◆ **The performance of the Landsat 8 OLI & TIRS sensors exceeds specifications, as well as TM and ETM+ performance, in all respects with one exception**
 - TIRS absolute radiometric correction and precision remains an issue under study
- ◆ **Performance of the ground system is outstanding**
 - Greater than 500 scenes captured and archived per day
 - ❖ Bumping up to 650 scenes per day
 - Level 1 data products typically available for distribution within 5 hours of data collection
 - Reprocessing of entire Landsat 8 data set completed in February, 2014

Web Sites

<http://landsat.usgs.gov>

<http://landsat.gsfc.nasa.gov>

<http://www.nasa.gov/landsat>

FaceBook Page

<http://www.facebook.com/NASA.Landsat>

Twitter Site

http://twitter.com/#!/NASA_Landsat